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ABSTRACT

To permit researchers to "random access" audio and/or video instructional segments for purposes of experimental assessment and intensive analysis, the Instructional Development Control and Monitoring System is being developed. Hardware and software to be used in the IDCMS system are described and the four phases in which the system will be developed are delineated. Future potential of the system also is explored. (SK)

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ABSTRACT

IDCMS is being developed in response to a number of Laboratory requirements. This document presents an overview of the hardware and software components of the basic IDCMS configuration and a multi-phase developmental plan designed to provide increased capability.

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OVERVIEW OF IDCMS DESIGN OBJECTIVES

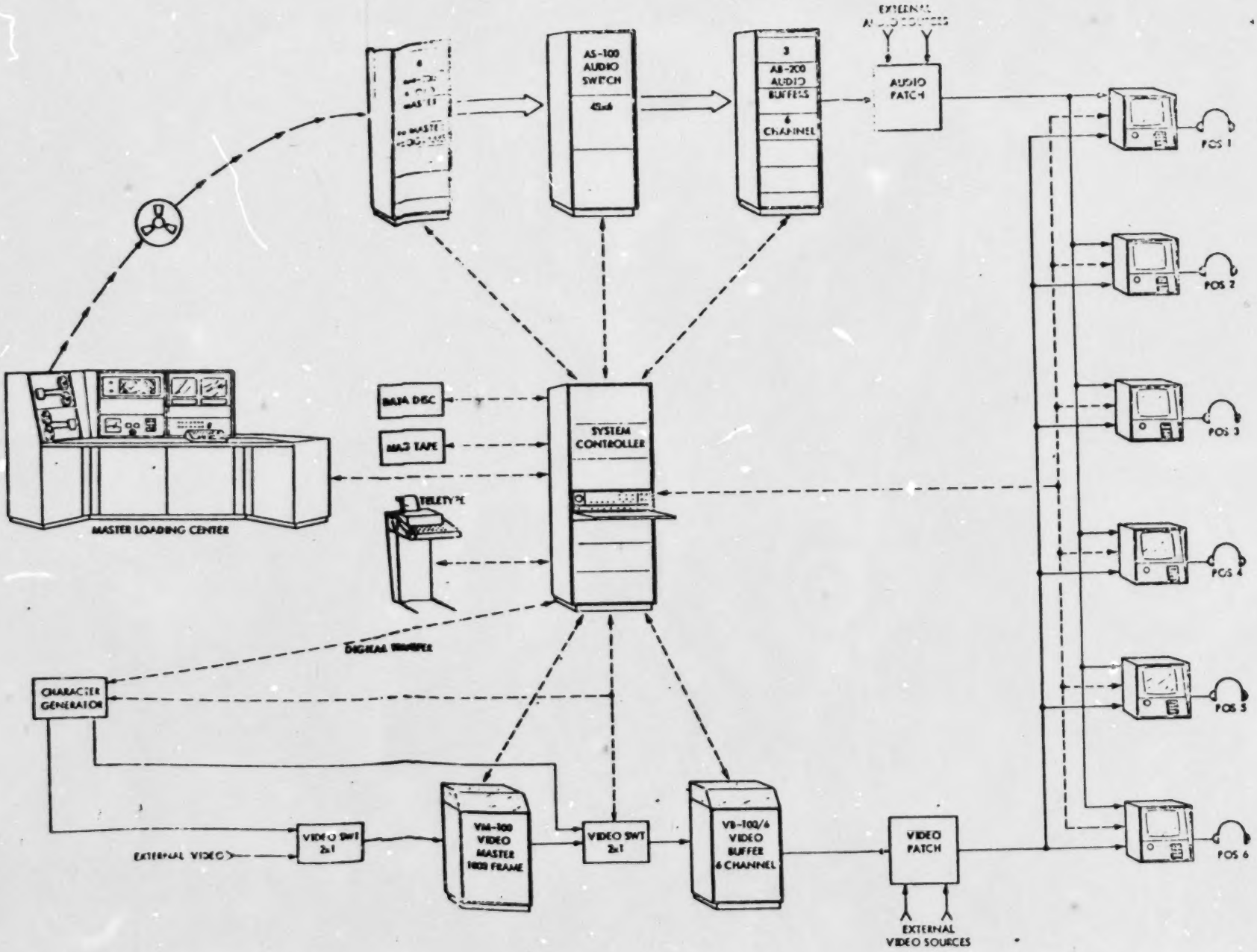
Frank Teplitzky

The Instructional Development Control and Monitoring System (IDCMS) is a powerful and flexible tool that permits researchers to "random access" audio and/or video instructional segments for purposes of experimentally assessing and intensively analyzing the elements of these segments. IDCMS contributes both to the technology of instructional research and to the development of specific instructional programs. This document describes the foundation upon which IDCMS is built and the phases in which it will be developed. The phases are necessarily tentative since technological advancements and special user requirements will undoubtedly modify current developmental plans.

Evolution of system architecture. The hardware foundation for building SWRL IDCMS capability was configured by AMPEX Corporation to SWRL specifications prepared in consultation with ASCI of Palo Alto. This configuration, termed IDCMS Version I hardware, is shown in Figure 1.

An important consideration in selecting Version I hardware was that it be of modular design to avoid obsolesence and that it permit functional as well as modular growth of IDCMS. Each increment in capability with be achieved with configuration hardware, computer software, and terminal design enhancements to provide the functional characteristics necessary for a range of educational R&D applications.

FIGURE


AS-100 AUDIO SWITCH
AB-200 AUDIO BUFFERS
6 CHANNEL
AUDIO PATCH
POS 1
POS 2
POS 3
POS 4
POS 5
POS 6
MASTER LOADING CENTER
DATA DISC
MAG TAPE
TELETYPE
SYSTEM CONTROLLER
CHARACTER GENERATOR
VIDEO SWT 2x1
EXTERNAL VIDEO
VM-100 VIDEO MASTER
VIDEO SWT 2x1
VB-100/6 VIDEO BUFFER 6 CHANNEL
VIDEO PATCH
EXTERNAL VIDEO SOURCES

PHASE I

During Phase I, SWRL Computer Center staff will develop IDCMS operating procedures and skills necessary to work with IDCMS hardware and software components. A limited but powerful set of functions will be made available to Laboratory researchers so that moderately complex experiments can be run. Phase I operations will generally include:

1. Presentation of audio and visual stimuli to a user according to preprogrammed instructions stored in a digital system controller.
2. Mixing of video tape and character generator information for presentation on portable TV monitors at user terminals.
3. Presentation of pictorial and alphanumeric visual information, in color or black and white, on the TV monitors.
4. Control of the rate of information presentation by terminal operators.
5. Synchronization of visual and aural presentation sequences.
6. Immediate access to all analog information stored in the system's master storage components by all terminal users.
7. Recording of user responses entered via a portable keyboard for off-line analysis.

The basic components of IDCMS, as depicted in Figure 1, consist of a system controller, an audio subsystem, a video subsystem, and terminal stations. The subsystems are briefly described below.

SYSTEM CONTROLLER

The system controller is a NOVA 1200 Mini-computer, a general purpose digital computer processor manufactured by Data General Corporation. Its primary function in IDCMS is that of system controller of all IDCMS

elements. Each user terminal is interfaced to the controller, and the command and control linkage between the keyboard and all other IDCMS elements is through the controller. Linkage is established by either preprogrammed instructions stored in the audio buffer in digital code form, or by operator commands. For example, a request for a particular audio/video program is entered by pressing the required program identification numbers on the requestor's keyboard. This action transfers the request to the controller, which initiates duplication of the program at the user terminal. After transfer, the user keyboard is placed in a control mode to provide complete control of the audio buffer assigned to that keyboard. Each device in IDCMS has a control interface to the controller for status sensing and control functions. The control interface serves as the digital multiplexer for the controller input/output bus. The controller stores digital data on a digital magnetic tape drive and on a 2.5 million character digital disk memory. Special control interface units are provided to permit data transfer between these units and the controller. In addition, an interface to an alphanumeric character generator allows textual inputs to be superimposed upon video displays.

AUDIO SUBSYSTEM

A terminal user can select any one of the programs at any time, and be given near-instant access to the complete program, regardless of the number of other users already using the program. This enables each user to have complete control over his copy of the program.

Operation of the audio subsystem is based upon AMPEX high-speed magnetic tape duplication processes. Each terminal has an individual audio buffer control. Upon request of an audio program through the keyboard, the controller interprets the request so that the selected audio program is duplicated at high speed from a selected track on a master audio reproducer onto the user's buffer. Thereafter, this copy may be manipulated and controlled by the user into stop, start, rewind, fast-rewind, and fast forward operations. Duplication speed of the program is 150 inches per second. Tape reels can hold up to 25 minutes of program play time. It will be possible to store a maximum of 96 programs at any one time during Phase I operation.

Audio-Video Synchronization

Audio-video synchronization is accomplished by digital control codes imbedded in the audio programming; on play, the codes signal the controller to select and present the corresponding video frames.

In Phase I the coded address will automatically synchronize the audio tape with the video images regardless of user manipulation of the program. Since these are absolute digital codes, a user may rewind or advance his program and still maintain audio and video synchronization. Each program will be able to access a maximum of 128 pictures, which will be called-in sequentially as the audio is presented.

Audio Tape Preparation

Programming control codes has been made simple and convenient for the developer of instructional materials through the use of the Mastering

and Loading Center equipment. A portable AMPEX Model AG500 tape recorder is used to record experimenter-developed audio inputs onto 2-track source tapes. As the original audio recording is played back, the operator enters a code and advances to the next code. The codes are released by the controller as a series of modulated 55 hz bursts which represent a binary digital code. The 55 hz signal is recorded on the second track of the source tape. The source tape is then placed on-line and its codes are merged as a subcarrier with the audio information onto one of the eight tracks on a Master reproducer tape. The audio tape and video inputs may then be previewed at the Mastering and Loading Center on TV monitors. When a 55 hz signal is encountered during the play, the controller senses an interrupt and presents the next picture.

VIDEO SUBSYSTEM

Video access is based upon storage of hundreds of individually recorded video frames or images on the surface of a magnetic disk in the VM-100 video master disk unit. Upon command, a movable head selects the requested image from the master disk unit and the image is played back and duplicated on a fixed head buffering disk (video buffer disk unit) and reproduced on the student monitor as long as desired.

Integrated multi-media system capability is available in that the same monitors may be used for alphanumeric presentations, live camera, cable TV, broadcast material, and video tape presentation.

Program material is added to the master video storage disk using a video camera and a character generator. The master video disk has an

1,800 video frame capacity. Forty frames are used for test signals and indexing, and 1,760 are used for instructional programming. The character generator, manufactured by Telemation Corporation, can combine with video inputs to form a composite of alphanumeric and pictorial frames that can be transmitted to the station's video buffer and then to the user TV monitor.

Video System Operation

The programs developed by the experimenter can be audio, video, or a combination of both. Video-only programs are requested by the user in the manner similar to the request for audio/video programs. Pictures within the video program are available to the learner in sequence by pressing the "PIX Advance" or "PIX Reverse" buttons. Each time a selected "PIX" button is depressed, the picture sequences are advanced or reversed by one frame. By continuously stepping through the video disk using the "PIX Advance", the impression of slow motion may be obtained.

STATION CONFIGURATION

Each of the Learning Lab carrels in Version I consists of an audio/video terminal with a responder keyboard. The terminal's video component is designed around the SONY 12-inch Trinitron color television receiver; the audio component is from the random access program material, routed to a head phone set at the unit. To communicate with the system, each terminal has a portable 12-button access, control, and response keyboard. The keyboard resembles a touchtone telephone panel

except that, in addition to numerals, video and audio control functions are also identified (see Figure 2).

EXPERIMENT CONTROL

In an experiment with instructional segments (i.e., pretest, training, posttest, evaluation) where the segments to be administered requires a decision, the experimenter will key in the identification of the next segment to be duplicated to his audio buffer. Segments will be played through to completion and the experimenter will control loops, skips, and extended alternative paths (see TN 1-72-01 for definitions).

PHASE II

Phase II general design goals are:

1. To provide random access video selection from any disk location. This will minimize the requirement to store duplicate copies for a program using a picture more than once.
2. To make available multi-program storage on audio master tape. Depending on the average length of an instructional segment, the audio master storage capacity will be significantly increased.
3. To develop an Experimental Control Language (ECL) to allow lesson developers to manage their programs more efficiently. ECL will be translated into Experiment Control Codes (ECC) by a batch mode computer translator program. These codes will reside in core memory and operate in synchronization with their audio program.

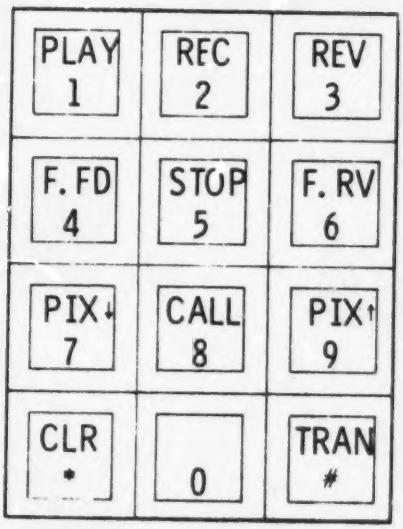


FIGURE 2

4. To expand the experiment control functions through newly defined EC codes. This is to include variable pacing, audio buffer control, etc.
5. To permit utilization of full alphanumeric keyboards at user stations.
6. To provide an automatic segment sequence control. This feature will allow the lesson developer to place an experiment control code in his instructional segment (or following it) to initiate the transfer of the next instructional segment to the user buffer automatically. This will automate interlesson branching and significantly reduce the overall lesson throughput time. The elimination of the requirement to manually key-in succeeding segments will also reduce keyboard input errors.

Even though most of the above items are computer software rather than hardware functions, another 8K core module must be added to the NOVA 1200 to permit programming of the functions.

PHASE III

By Phase III it is expected that Lab researchers will have had the necessary hands-on experience to contribute suggestions for making IDCMS easier to use and more appropriate to their needs. Toward this end, the following design objectives are planned:

1. The experimenter will be provided with an on line interactive capability to permit him to manage his instructional sequences

even though others are using the hardware. Included will be an interactive program management capability which will allow him to:

a. enter a new ECL source program

b. edit programs to resequence the EC instruction set

c. save or delete program files

d. execute programs

Any combination of these operations can be performed at any station even though users at other stations may be performing other operations. In many respects IDCMS will resemble a mini-timesharing system, except that computer program development and system utility operations will need to be separately scheduled.

2. The implementation of "arithmetic operators" will provide a particularly powerful tool for the experiment designer. The operators will provide loop count control, student path tracing through a program, group path tracing, counter based automatic call-in of new program segments (computerized decision making), and so forth.

3. Intra-audio buffer branching will be explored during this phase. The development of this capability will allow the computer to control audio buffer fast forward, reverse, etc. in a measured way.

Phase III enhancements to IDCMS capability will involve a combination of hardware modification, additional core memory, and skillful computer programming.

PHASE IV

The NOVA 1200 controller lacks the ability to perform complex on-line, real-time analyses of user response data primarily because it has insufficient capacity to accomplish analyses and system control simultaneously. A Phase IV design objective is therefore to extend IDCMS capability to the point where it can provide the experimenter with computational power beyond the limits of the NOVA 1200 mini-computer. To accomplish this, an on-line interface with either a large time-shared or a remote batch computer will be developed. This will allow the raw data of an experiment to be transmitted via telephone lines to the larger computer for detailed analysis. Once the data are processed, the reports generated, and the data bases are updated, the results will be transmitted back to the NOVA to be printed or used as criteria for computerized decision making.

ADDITIONAL IDCMS POTENTIAL

A potentially exciting aspect of the IDCMS developmental effort is in the area of input/output devices to broaden the range of response and feedback mechanisms. In TN 1-72-02, Follettie describes a variety of educationally useful response categories that can present a high order of flexibility for researchers. The use of speech comparators and analyzers, for example, are devices that offer great promise in the field of voice input/output. Tied to the Language Analysis Package and Music Analysis Package being developed at SWRL, computerized speech and music response evaluation may be investigated.

The concept of IDCMS is unique. Its development will be affected by Laboratory priorities and by technological advancements internal and external to SWRL. Full exploitation of IDCMS potential will require both resourceful computer system developers and imaginative and purposeful users.

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